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Information asymmetry, contract design and process of negotiation: The stock options awarding case ☆

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Abstract

Stock option plans are used to increase managerial incentives, and business practices usually set the exercise price equal to the stock market price. The purpose of this paper is to underline the importance of a process of negotiation leading to a possible equilibrium contract satisfying both managers and shareholders. The two key variables of the model are the percentage of equity capital offered by the shareholders to the managers and the exercise price of the options that may be at a discount. We explicitly introduce risk aversion and information asymmetries in the form of (i) an economic uncertainty in the gain of cash flow, (ii) possibly biased information between the two parties and (iii) a noise in the valuation price of the stock in the market. The existence of a process of negotiation between shareholders and managers leading to a possible disclosure of private information is highlighted. As a conclusion, we show that "efficient" stock option plans should be granted in a context of trade-off between the percentage of capital awarded to managers and the discount in stock price.

JEL classifications: G3; G3; G35; K2
Keywords: Stock options; Optimal incentive contract; Asymmetry of information; Negotiation; Managerial power

1. Introduction

Awarding stock options is seen as a standard contract where the exercise price is systematically set at the market price and where the number of options is arbitrary. Recent events in the United States in the hightech industry showed that the story is more complex. Firms and managers have taken the opportunity to time the best moment for them to issue stock options. In particular, they use periods when the stock price seems under the value to settle the exercise price of the stock options. The possibility of resetting the exercise price when an adverse evolution of the stock price occurs is also used. To reinforce the incentive characteristics of stock options, exercise prices are reset at lower market

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price in a situation of declining stock market. This occurred after the Internet crash at the beginning of the 2000s. The use of back-dating before the Sarbanes–Oxley regulation also appeared to be common for setting a discounted exercise price. Moreover, setting the exercise price equal to the stock market price is a poor practise as it does not take account of the fact that the market idiosyncratic price can be affected by a positive or a negative bias, compared to the true fundamental value of the firm. Managers, when they are awarded stock options, have better information compared to stockholders about such possible discrepancies. It suggests that apparently at-the-money stock options to shareholders' eyes are not to managers' eyes.

The framework differs in other European countries, particularly in France where it is possible to issue stock options with a maximum legal discount of 20% compared to the market price. A regulation adopted in 2001, that allows discounts of up to 30%, applies to employee stock purchasing plans. In other countries, like Australia or Denmark, in-the-money or out-of-the money stock options are often used in managers' compensation schemes. Designing the parameters of stock option plans is of utmost importance. Because a transfer of value may be induced by using a discounted exercise price, a joint equilibrium must be sought by the shareholders to maintain an incentive pressure on managers and executives. The possibility of a discount outlines the dilutive effect of awarding stock options. These in-the-money options have a high ex ante probability of exercise, so the holdings of old shareholders can be diluted if they award too many stock options. The percentage of capital awarded to managers then plays an important role in setting the contract. The purpose of this paper is to outline the utility of a negotiation process on the characteristics of a stock options contract between managers and stockholders.

Apparently, few studies were devoted to the link between the contractual design of a stock option plan and its incentive effects on the managers' efforts. The analysis presented here takes the view that compensation negotiation is used to minimize agency costs and helps to disclose private information. Throughout this article, a stock option plan is considered used for developing managerial incentives.[1] Appropriately stimulated managers will generate larger cash flow in the firm. The main question is to determine whether a jointly optimal incentive contract, that is a contract satisfying both managers and shareholders, exists or not. The analysis has to take place within a framework of moral hazard and information asymmetry between the two parties. Equilibrium contracts exist through a designing process driven by shareholders. We focus on the possibility of a joint contract that will reduce the information asymmetry between managers, who are presumed better informed about the economic perspectives and the future profitability, and shareholders who are traditionnally presumed to hold the power of whether to grant stock options. The setting of an optimal incentive contract is an important theoretical issue that has been extensively analyzed in principal/agent literature. However, we favor the context of the "managerial power" approach of Bebchuk and Fried (2003) who underline that the agents have enough power to set their own pay, or that of Ryan and Wiggins (2004) who emphasize the importance of a bargaining process in determining the compensation schemes. Like Choe (2003), we stylize the design of a stock option plan in a firm as a set of two choices about the stock exercise price and the percentage of capital awarded to managers. The analysis developed hereafter will focus on the trade-off between these two parameters of the contract from each party's point of view. If we referred only to a framework of risk-neutral and equally well-informed players, nothing would ensure a joint optimum contract. As a result, taking into account both the incomplete information of shareholders and managers' risk aversion is necessary to show the existence of a possible joint equilibrium contract. Like Bolton et al. (2006), we also integrate the risk for managers that the stock price when setting the contract may deviate from the fundamental value of the firm. Strategies of manipulation of information have to be addressed in a world where managers have better information on the probability of success for their effort. We show that the process of negotiation in a world of information asymmetry and manipulation may reveal private information.

This article is organized as follows: the existing literature is reviewed in the next section. Thereafter we present the model for contract design and the behaviors of shareholders and managers in a context of information asymmetry. The negotiation process is presented in Section 4. Finally, the conclusion highlights the main results of the paper.

2. Literature review

Stock option plans have been largely justified within agency theory. Stock options are initiated by shareholders and are used to motivate managers. It is assumed that the latter develops additional effort to create value which in return will

[1] We refer only to underwriting stock option plans, which will from now on be called "stock option plans". Purchasing stock option plans seem to be dominated by underwriting ones (Desbrières, 1997). Moreover, they are not very often used.

maximize the shareholders' utility (Jensen and Meckling, 1976). The first problem considered in the literature on incentive contracts is the issue of the existence of an optimal contract in the principal/agent problem (Hart and Holmström, 1987; Laffont and Martimort, 2002). The role of information is addressed and some important assumptions are analyzed in this approach. Harris and Raviv (1979) mention the importance of the risk aversion hypothesis in the setting. If the agent was risk neutral, there is no gain from monitoring the agent's action. Looking at exogenous economic uncertainty, the principal and the agent have common beliefs about the distribution of the random states. A possible asymmetry of information is not taken into account by Harris and Raviv. They draw the important conclusion that the process of supervision of the agent by the principal and the design of the category of contract is part of the problem of the setting of the optimal incentive contract. Optimal contract theory also shows that a set of feasible optimal contracts exists through a bargaining process between parties (Myerson, 1979).

Lambert, Larcker and Verrechia (1991) pointed out that the incentive effect of a stock option plan depends on the degree of risk aversion of the managers and the uncertainty level of the firm's activity. Ross (2004) also underlines the importance of the managers' risk aversion to explain that an incentive fee schedule will not unquestionably lead to an increase of the risk level of the firm. Hall and Murphy (2002) considered the situation of undiversified risk-averse managers and showed that the incentive effect is maximized if options are granted with exercise prices slightly below or at the market price. Some empirical studies address the question of a link between stock options award and the risk-taking attitude of the firm. The positive link which is expected is confirmed by DeFusco et al. (1991) and Brookfield and Ormrod (2000) in the United States and by Hjortshoj (2007) in Denmark. The latter introduces moneyness in his empirical studies. He shows that out-of-the-money option grants increase risk-taking, while deep-in-the-money option grants reduce managerial risk-taking. Consequently, the moneyness feature of stock options appears as a tool in solving the managers' under or over-investment problem in the manager-shareholders agency conflict. At both a theoretical and empirical level, it justifies setting the exercise price below or above the traditional at-the-money choice in an incentive context.

The standard agency theory analyses the agency problem with symmetrical information. Holmstrom (1979), and Grosman and Hart (1983) specify an economic profit linked to an effort developed by the managers. The agent receives a compensation relating his payment to his effort. Traditionally, literature on incentive contracts adds an incentive compatibility constraint. The agent chooses the best effort to maximize his expected utility. A set of individual rationality constraints will insure that the two parties will participate in the game. One party, i.e., the board of the firm, has the power to design and to propose an (optimal) contract. The logic of designing the terms of the contract is deterministic if information is equally shared. Even if asymmetry of information is taken into account in the modeling, the optimal contract approach does not focus on the uncertainty of a bargaining process (see Murphy, 1999; or Core et al., 2001, for surveys).

The development of a negotiation will in itself gradually convey pieces of private or biased information between the two parties. If, as seen above, the managers can renegotiate existing stock option plans, we should accept the idea that they can influence the setting of a stock option contract. Yermack (1997) for instance analyzed the link between the date of awarding stock options and firm news announcements. The dilution of the shareholders' wealth seems also to play an important role in the equilibrium between the two parties (Martin and Thomas, 2005). The "managerial power approach" insists on the rent-seeking behavior of managers. They interfere in the design of their compensation schemes (Hall and Liebman, 1998; Bertrand and Mullainathan, 2001; Bebchuk et al., 2002). Compensation schemes, particularly stock options, are not only incentive tools optimally designed to provide a remedy to the agency problem. They also appear as reflecting the agency problem itself (Jensen and Murphy, 1990a,b, 2004). The idea that an informal or implicit negotiation process develops within a framework of asymmetry of information between the managers and the board, on behalf of the shareholders, has been highlighted by Bebchuk and Fried (2003). The bargaining between the two parties can lead to rent-seeking compensation schemes. The process of determining the compensation schemes, particularly stock options, was analyzed as a negotiation and a bargaining process by Ryan and Wiggins (2004). The managerial self-dealing hypothesis has also been documented by Sautner and Weber (2006). Considering European firms, they show that firms with weak corporate governance and powerful managers have designed stock option programs favorable to executives. The managerial power hypothesis offers a new approach to understand the process leading to jointly agreed stock option contract, which is not the optimal contract imposed by the standard incentive theory that gives the bargaining power to shareholders. Choe's (2003) model determines endogenously the stock option contract features and introduces parametrization of the exercise price and the size of option grant. In conclusion, Choe suggests to develop further analysis to question the optimality of the traditionnal at-the-money setting practise and to introduce managers' risk aversion.

Otherwise, the standard view of stock option compensation rests on the fundamental hypothesis that stock prices are unbiased estimators of a firm's fundamentals on which CEOs could be paid to reward managerial effort. Bolton et al. (2006) presented a multiperiod agency model of stock based executive compensation in a speculative stock market, where stock prices may deviate from underlying fundamental stock prices. Managers are then exposed to a short-term speculative risk they integrate in setting their effort function.

Managerial compensation contracts have also been studied from the behavioral point of view. Overconfidence is often evoked to better understand behaviors or choices when contracting. Behavioral finance applies to financial markets and deals with overconfidence errors by analysts or investors. It also focuses on the effects of overconfidence that are internal to the firm; for instance, behavioral costs appear when people make errors because of cognitive imperfections or emotional influences. Shefrin (2001) considers that incentives are of critical importance for value maximization, but they cannot alone overcome the internal behavioral obstacles. Keiber (2005) analyzes how overconfidence affects the internal principal/agent relationship. He concludes that, when principal and agent are assumed to be overconfident, the design of incentive compensation contracts is modified with moral hazard and symmetric information structure. Although promising, we do not take into account behavioral biases. Thereafter, it is still assumed that both parties are rational.

At the factual level, in the United Sates, the setting of the exercise price of stock options is traditionally done at the market value at the grant date. Hall and Murphy (2002) note that 94 percent of the stock options awarded to the S&P companies in 1998 were at-the-money. As a result, this contractual characteristic is not *per se* taken into account in empirical studies. Aboody et al. (2004) explains this by the fact that discounted stock options are taxed in the United States legal system. They are not deductible under the Internal Revenue Code if an excecutive total option based compensation exceeds $1 million a year (Narayanan and Seyhun, 2006). Moreover, FASB accounting rules require that the discount should be expensed. The common at-the-money setting explained by the Accounting Principles Board no. 25 opinion which set that the at-the-money option programs had not to be expensed. The firm had only to disclose a pro forma net cost with a fair-value evaluation of stock options at the evaluation date. The FAS no. 123 rule issued in 1995 recommended considering stock options as an accounting expense and to value them at "fair-market value". However, this rule provided the choice to continue reporting according to the old APB opinion as noted by Hall and Murphy (2003). From 2005, according to the US-GAAP, the cost of all types of stock options should be expensed. Internationally, under the new IFRS 2 rule, stock options should also be expensed using fair value. These new accounting standards are no more not biased in favor of at-the-money setting. Since 2002 and the SOX regulation, back-dating are more constrained by an accelerated disclosure requirement (Section 403). By limiting the notification time, the regulation cancels out back-dating. The possibility to ex post discount grants is limited (Narayanan and Seyhun, 2006). Sautner and Weber (2006) mention that the European institutional context explains large variation in stock option features. This factual context explains why an empirical test of the influence of moneyness has been carried out in only a few countries, i.e. Denmark and Australia, and not in the United States. Moreover, empirical studies on the features of stock option plans are not easy because of the lack of transparency and data availability. Hjortshoj (2007) considering 397 stock options grants in Denmark shows that the average moneyness of his sample was 0.98 with a standard deviation of 0.51. Deep in-the-money and far out-of-the money stock options are not rare in that country. An empirical test made by Canil and Rosser (2007) in Australia identified 168 stock option grants of which 55 were awarded at-the-money, but 65 were discount grants and 48 premium grants. The definition of discount or premium stock options is set using a 5% threshold under or above the stock market price at the grant date. They cross moneyness with the relative grant size, i.e. the number of shares awarded compared with the outstanding number of stocks, and get a U-shaped relationship with large awards when discount or premium stock options contracts are set up, and smaller awards for at-the-money stock options. They do not provide any analytical explanation for that empirical feature. Canil and Rosser also show that small (large) grants are characterized by positive (negative) abnormal stock market returns, which underlines the importance or the fear of dilution by shareholders.

3. Contract design and shareholders' and managers' behavior with asymmetry of information

We do not follow the traditional literature on optimal incentive contracts, but focus on the joint process of negotiation in a rational context where both parties are exposed to different sources of uncertainty and managers are risk averse. Information asymmetries exist and this disequilibrium generates a specific risk in contracting: the risk on the available information. Information risk has consequences in the setting of the optimal economic contract because the process is exposed to strategic manipulations or entails problem of trustworthiness. Such an approach could be developed to analyze the managers' whole compensation policy. We will consider only a stylized stock option contract as an example of a long-term incentive contract. The design of the contract limits itself to the determination of two parameters: the exercise price relative to the current market price, i.e moneyness, and the percentage of capital awarded to managers, i.e. grant size and dilution.

3.1. Model presentation

The setting and the effects of a stock option plan are analyzed through a two-period model. The plan is adopted at time $t=0$. At this date, the cash flow X_0 is known. At time $t=1$, the firm generates a cash flow X_1, which is possibly increased by the manager's efforts. We presume that this cash flow is constant from $t=1$ to infinity. The model does not take into account any taxation. The managers can exercise their options at time $t=1$ at the exercise price E, fixed at the setting of the contract. The key variables of the model are k, the relative part of the equity capital given to managers by shareholders, and E, the exercise price of the options. The variable k is a percentage of the initial number of shares, N. The values of k, as well as the exercise price E, are ultimately set by shareholders who wish to maximize their wealth. Managers behave in such a way as to maximize their wealth by realizing a capital gain through the exercise of their options.[2] The firm is valued on the market using a risk adjusted rate r.

The following notations will be used:

V_0, V_1	current and future values of the firm
C_0, C_1	share prices at $t=0$ and $t=1$
X_0, X_1	current and future cash flows
N	number of shares which belong to shareholders at $t=0$
k	proportion of initial capital given to managers through options
r	risk-adjusted discount rate
E	exercise price of options
Wm	managers' wealth
Ws	shareholders' wealth

We will focus on managers' wealth.[3] The variables k and E characterize the stock option plan. The initial discount (C_0-E) is supposed to be non-negative. The assumption is that managers will always exercise their options even if they make no effort because they will profit from the initial discounted exercise price (Hall and Murphy, 2002). So, it is not necessary to refer to option valuation models.[4] We are looking for optimal equilibrium conditions between shareholders and managers, knowing that each one wishes to maximize his utility in some cases, or his expected utility in other cases. We will not use bargain analysis because the negotiation process we would like to analyze should not be constrained at the beginning. Optimal contracting theory is often based on the allocation of the bargaining power to one agent, the other being ruled by the simple satisfaction of a reservation utility constraint (or individual rationality constraint) or to Nash solutions in game theory. Here, we seek to highlight the dynamics of negotiation regardless of the bargaining situation and the relative power of the two agents. The uncertain future increase in cash flow is: $e(.)=e[U(W_m)]$. We call it effort function because it corresponds to the result of the effort of continuously stimulated managers. We assume that a positive effort function exists and depends on the managers' (utility of) wealth. The utility function of managers, because of risk aversion, will moderate the impetus of a direct increase of wealth following the stock option plan. The effort function $e(.)$

[2] The stock options are non-tradable call options. In our context, it means that the managers can only exercise them at $t=1$ without any possibility of going short at time $t=0$.

[3] The analysis is developped in discrete time with an assumption of no previous stock option plans or prior ownership of stocks by managers. However, the model is robust if we take into account prior ownership of equity capital by the managers. It will push them to deliver more private information about the fundamental value of the firm to other shareholders because of their increased exposure to a market noise; it will also strengthen the alignment of managers with shareholders by curbing their optimal curve to more positive slopes and facilitates the conclusion of contracts. We thank a referee for pointing out the possibility of managers' prior ownership.

[4] Because our analysis focuses on the trade-off between the discount in value and the dilution effect, we do not consider the optional feature of stock options. Ex ante, the exercise at $t=1$ is assumed; so we do not need to refer to option valuation models in a multi-sequential framework.

is positive, is increasing and converges to a positive finite limit, e_{max}. It has a defined derivative. Here, the effort function is the result of the action, not the action itself. In a traditional setting, a cost function (for instance quadratic) is associated with actions and will lead to an optimal effort by introducing an exogenous limit in the optimization and driving the marginal benefit of effort to zero. In our framework, managers should maximize their utility looking only at the positive impact of incentives. In that sense, our setting assumes that the incentive hypothesis is true and that the managers' incentive compatibility constraint is verified. The convexity and the convergence on a limit incorporate a decreasing "productivity" of the marginal stimulation of the managers. The convergence sets that, at the limit, some marginal cost balances the marginal productivity of the managers' effort. The managers' (additional) wealth depends on the portion of initial capital given to them, k, and on the exercise price, E.

The increase in cash flow, $e(.)$, compared to the last known cash flow, X_0, is due to two mixed factors:

- A decrease in discretionary and ineffective managers' expenses.
- A pure cash flow increase due to gain from managers who exploit all possibilities of profit making within the uncertain economic environment of the firm. The existence of such a pure gain means that the firm was not at its economic optimum.[5]

We suppose that, at least, one incentive equilibrium exists between shareholders and managers. The latter calculate the consequences of a global equilibrium on their wealth and act on this basis. At equilibrium, the value of the cash flow gain is a constant, fixed and determined by optimal choices with regard to k and E. So, we have:

$$e^*(.) = e\left[U\left(W_m\left(k^*, E^*\right)\right)\right] \tag{1}$$

If the values k_m^* and E_m^* imputed from the managers' wealth do not correspond to the optimum, shareholders do not maximize their utility with regard to the extra wealth created by managers and from which they benefit. This situation corresponds to the "equilibrium valuation schedule" introduced by Leland and Pyle (1977). We characterize this situation as the optimal incentive contract between shareholders and managers.

The shareholders consider the effort function to set their optimal proposition to managers. We adopt the following convention: $e(.) \equiv e[U(W))]) = f[W_m(k,E)]$, so $e_k'(.) = f'[W_m(k,E)].dW_m/dk$ which is abbreviated to $f'.dW_m/dk$. The function $f(.)$ summarizes the increase of cash flow due to the managers' effort and the utility of their wealth.

3.2. Economic uncertainty and symmetrical information

In this section, we explicit uncertainty by weighting the extra gain of cash flow with an exogenous probability p. The value p will correspond to the probability for the firm to become economically more efficient and to yield more cash flow. It depends on exogenous states of the Nature. Managers and shareholders cannot be sure of the success of the effort made by the latter and the gain can be null with a $(1\text{-}p)$ probability.[6] In the latter situation, the stock option plan will result in an appropriation by the managers of a part of the firm's value through the discount $(C_0 - E)$ they are awarded. Here we suppose that both parties are facing the same outcome uncertainty, share the same information on p and are risk neutral. Because of risk neutrality, utility function is ignored. We have two possible cash flows which lead to two possible values of the stock price respectively C_1^+ *and* C_1^-*:*

$$X_1^+ = X_0 + e\left[W_m^+\right]$$
$$X_1^- = X_0$$

In a framework of information symmetry, the best percentage of issued capital for managers is the maximum one (for positive values of p). The managers are aware of their effort function and they know exactly the probability-weighted increase of cash flow. The choice of an optimal stock option contract for managers, if they were able to impose their conditions, is not a relevant problem. Any positive grant of stocks options ($k > 0$) leads rational managers

[5] We should not consider the hypothesis of a negative additional cash flow because if managers do nothing more, the firm's cash flow will remain the same, so the effort function is positive or null.

[6] We eliminate the idea that the cash flow becomes lower after a stock option plan than before. See previous footnote.

to exert maximum effort e_{max} to achieve the maximum increase of cash-flow. That maximum gain in cash flow results in a deterministically known stock value, $C_1(e_{\max})$.[7] The optimal value of the effort function, from the point of view of the managers, is either $e^*(.)=e_{\max}$ (if $E^*<C_1(e_{\max})$) or $e^*(.)=0$ (i.e. pure opportunism). The design of a contract here is not relevant because, for any positive amount of option grant, the managers will choose the maximum effort. At $k=0$, the function $e(.)$ is not differentiable and, for the value $e_{\max}$, its derivative versus k (or E) is zero. Thus, we do not get any trade-off between the two parameters k and E at the optimal situation. Here, we simply know that, for the managers, even if their wealth depends on both the discount effect and the dilution effect, the unique optimal situation is a maximum where no trade-off exists between these two effects.

Turning now to the situation of the shareholders, we have to consider the two effects of (i) the dilution of their wealth ensuing from a discounted subscription price and (ii) the uncertain increase in the economic cash-flow. The shareholders' wealth is:

$$Ws = \underbrace{N.C_0}_{\substack{initial\\wealth}} - \underbrace{\frac{k}{(1+k)}.N.(C_0 - E)}_{dilution} + \underbrace{p.\frac{1}{1+k}.\frac{e(.)}{r}}_{gain\ of\ value} \tag{2}$$

The set of optimal contracts for shareholders will respect the relationship:[8]

$$\left(1+k_s^*\right).e'_k(.) - e(.) = N.\left(C_0 - E_s^*\right).\frac{r}{p} \tag{3}$$

Looking at shareholders, we get a simple equilibrium relationship between k^* and E^*, which defines their locus of optimal situation. This relationship gives an infinite number of solution (k_s^*, E_s^*). The logic behind an optimal value of the percentage of issued capital comes from the risk of dilution of the capital. Many different optimally built contracts can be chosen by shareholders. The shareholders will design the terms of the stock option plan by choosing their optimal values k^* and E^*.

The shareholders' equilibrium optimal contracts (3) are characterized by a trade-off.[9] The shareholders stimulate managers either by offering a large part of the capital or by offering a discount through the exercise price. The optimal percentage of issued capital k_s^* in a trade-off scheme (i.e. $dk_s^*/dE_s^*<0$) is a function of the genuine probability of obtaining extra cash flow. If, in itself, p does not modify the sign of the function, it affects the slope of the curve and conditions the terms of the trade-off.[10]

The shareholders will select a single optimal contract from the infinite number of best contracts.[11] The contract will be the one that would appear if the shareholders have full bargaining power, i.e. when they can make a "take-it-or-leave-it" offer to the managers. Similarly, from the managers' point of view and taking into consideration the shareholders' participation constraint, the program will lead to a solution contract assuming that the managers have all the bargaining power. These two situations are "corner solutions". Introducing these constraints will, hypothetically, exclude a process of negotiation and limit the contract to a simple take-it-or-leave-it mechanical problem. As a result, the process of designing a fair joint contract for managers and shareholders does not develop although information is shared equally. No negotiations will take place. There is no need to exchange information.

[7] We have: $C_1(e_{\max}) = \frac{X_0+p.e_{\max}}{(1+k).N.r}$. The value $C_1(e_{\max})$ also depends on choices with regard to k.

[8] This corresponds to the first order condition of the shareholders' wealth with regard to k. The derivative of W_s with regard to E is always positive; it results from the shareholders' wealth which is an increasing function of the exercise price of the options.

[9] It will be proved later in the more general case.

[10] We recall the existence of a participation constraint for managers, corresponding to the individual rationality condition (IR):$C_1(e) = \frac{X_0+p.e(.)}{(1+k).N.r} \geq E$. When p is small, and the discount not very large (high E_s), the IR constraint may be binding. So with low p values, E_s should be lowered. When, in the same situation, managers are granted a large discount, this transfer of value reduces the part of their wealth depending on the uncertain gain of cash flow. So, their sensitivity to the percentage of awarded capital is lower. The same is true when the probability of success is high, and when the part of the managers' wealth coming from a gain of cash flow is greater (i.e. for low discounts), we then have a lower sensitivity to the share of capital given to managers.

[11] In the above framework where the optimal utility of the managers depends only on a fixed value $e_{\max}$, the optimal stock options contract for the shareholders will be the one with k slightly positive but close to zero, and E slightly below $C_1(e_{\max})$. Obviously, it leads to "out-of-the money" option plans with positive premiums that were excluded by hypothesis.

The above conclusions result from the hypothesis that the probability p is equally identified by both parties who are risk neutral when contracting. The framework of a common symmetry of information vis-à-vis an uncertain future economic cash flow has to be reconsidered. For risk-averse agents, what is important is the risk of a difference in information when contracting. Risk aversion is not per se enough, but will enhance the role of asymmetry of information when contracting. The purpose is to analyze the design of the optimal contract when the bargaining power is shared and unconstrained between the two parties. The equilibrium trade-off is a joint compatibility condition not for a given solution, but for a possible process of negotiation regardless of the bargaining power. We will consider the case of shareholders and managers respectively.

3.3. The case of information asymmetry for shareholders

In a more general setting, we have both to abandon risk neutrality and to introduce information asymmetries between the two parties. Here, we will see that the behavior of managers changes because of an uncertainty in their expected wealth. Their optimal effort depends on their risk aversion. The managers are risk averse because of the lack of diversification of their wealth. Although facing an asymmetry of information, we still consider shareholders as risk neutral.[12] In that context the optimal gain becomes a function of k and E, which is derivable for the two parties.

Managers know the real probability p to achieve an economic cash flow gain because they are insiders. They systematically profit from better information available to them and not to shareholders. What we want to model here is an information asymmetry vis-à-vis the shareholders considered as a whole. We assume that managers still have information of the economic profitability of their effort even if the occurrence of profitability remains uncertain.[13] Shareholders are facing incomplete information on the probability of getting an increase in cash flow. They receive an optimistically biased message from the managers who know the real exogenous probability p of success in increasing the cash flow. The bias leads to an announced probability of profit, p^r, above the true probability of success, p. Shareholders will use p^r as far as this is the only piece of information they are given. Rational shareholders are not naïve in the sense they know that p^r can be manipulated. Shareholders know that the information p^r entails a bias of which they estimate the size b. The size of the bias is prior information. It is exogeneous and comes from the previous relations between managers and shareholders of the firm. For instance, if trustworthiness is low between the two parties, the bias is systematically exaggerated.[14] Non-naïve shareholders will receive information from the managers and try to filter it from manipulation or bias. It will allow the beginning of a process of negotiation. As a first step, the shareholders correct the reported p^r to build a prior forecast p' of the probability of success. We have:

$$\tilde{p}' = p^r - \tilde{b}$$
$$E\left(\tilde{b}\right) = b \geq 0$$

Moreover, we now presume that a random noise exists in the market which modifies the share value at time t_0, like Bolton et al. (2006). Thus, the increase in the discount given to managers is disturbed during periods of bull or bear markets that can lead to discrepancies compared to the discounted value of the future cash flow of the firm. Shareholders do not know precisely what is the true economic value, C_0; managers know this. In an efficient market, a possible mispricing is temporary and is considered by shareholders and managers as white noise with a expected value

[12] Managers invest both their human capital and their financial capital (ensuing from the awarded stock options) in the firm. Shareholders can diversify their portfolio in the stock market. They are exposed to a specific risk by contracting with the managers. That risk is a risk of opportunism (i.e. a pure dilution risk) and a risk of information in estimating the magnitude on the gain in cash flow. These risks are specific in the sense that they do not exist in a firm where no stock option plan is granted to managers. These contracting risks are diversified in portfolios where different firms are invested. Extension of the model to take into account risk-averse shareholders is possible. It leads to more complex and less clear-cut results, but globally the conclusions are unchanged.

[13] This basic information asymmetry justifies itself because, for instance, starting from an under-investment situation, managers know the real return of investment projects they can launch. More generally, they know the shape of their effort function. When focusing on information asymmetry what is important is the relative difference in the information set of the two parties. So we continue to assume that managers have perfect inside information on the value of p.

[14] A new relationship between two parties creating a new firm entails an average bias set to zero by shareholders who trust the information delivered by managers. We can also imagine a bias of modesty coming from experience that very trustworthy managers will systematically underestimate the probability of achieving a successful gain in cash flow. Hereafter, we rule out this possibility, assuming a positive or null bias, but it can be supported by the model.

of zero and an estimated prior variance var*(a)*. The stock price in the market, $\tilde{C}_0^M$, just before inception of the contract, is:

$$\tilde{C}_0^M = C_0 + \tilde{a} = \frac{X_0}{N.r} + \tilde{a}$$

Shareholders calculate their wealth using the noisy, but on average unbiased, market price $\tilde{C}_0^M$, they look at and incorporate the future gain of cash flow. They also try to estimate the true probability of success. After setting the contract, their wealth is:

$$Ws = N.(C_0 + \tilde{a}) - \frac{k}{(1+k)}N(C_0 + \tilde{a} - E) + \left(p^r - \tilde{b}\right).\frac{1}{(1+k)}.\frac{e(.)}{r} \tag{4}$$

We set the derivatives of the expected shareholders' wealth with respect to E and k to zero.

$$\frac{\mathrm{d}E(Ws)}{\mathrm{d}E} = E\left\{\frac{\mathrm{d}Ws}{\mathrm{d}E}\right\} = \frac{k}{(1+k)}.N + (p^r - b).\frac{1}{(1+k)}.\frac{e'_E}{r} \tag{5}$$

The sign in (5) is always positive and has a clear meaning to shareholders.[15] The other derivative is more important in obtaining first order condition.

$$\frac{\mathrm{d}E(Ws)}{\mathrm{d}k} = -\frac{1}{(1+k)^2}.E\left\{N(C_0 - E) + N.\tilde{a} - \frac{p^r}{r}.e'_k(.).(1+k) + \frac{\tilde{b}}{r}.e'_k(.).(1+k) + \frac{p^r}{r}.e(.) - \frac{\tilde{b}}{r}.e(.)\right\} \tag{6}$$

The expression between brackets in (6) is set equal to zero in order to find the optimal values of the variables k_s^* *and* E_s^* for the shareholders. It leads to the following optimality condition:

$$Fs = \left\{N\left(C_0 - E_s^*\right) + p^r\left(\frac{e(.)}{r} - \left(1 + k_s^*\right).\frac{e'_k(.)}{r}\right) - b.\left(\frac{e(.)}{r} - \left(1 + k_s^*\right).\frac{e'_k(.)}{r}\right)\right\} = 0 \tag{7}$$

A stock option plan is defined by a set of values (k^*, E^*). At equilibrium, the relationship between k and the discount has an unknown sign. If we call Fs the left side of (7), the sign of dFs/dE is negative; it underlines that the incentive equilibrium Fs is a negative function of the stock subscription price, E^*. An increase in E^*, which improves the shareholders expected wealth, means a decrease in Fs. The sign of dk_s^*/dE_s^* is equivalent to the sign of dFs/dk_s^*.[16] Looking at (7), dFs/dk_s^* gives:

$$\frac{\mathrm{d}Fs}{\mathrm{d}k_s^*} = -(p^r - b).(1+k).\frac{1}{r}.\frac{\mathrm{d}e'_k(.)}{\mathrm{d}k_s^*} > 0 \tag{8}$$

Knowing that de'_k/dk_s^* is negative, the sign of dFs/dk_s^* is positive.[17] Consequently, the sign of dk_s^*/dE^* is positive. Shareholders will design the stock option contract following a trade-off between discount in exercise price and the percentage of awarded equity.

In a context of information asymmetry, shareholders do not know the exact location of Eq. (7) in the (E_s, k_s) plan. When anticipating the effort function *e(.)*, they do not know the shape of the utility function of the managers *Um(.)*. They also do not know the true value of the success probability p, but they have a piece of prior information p', obtained by correcting the reported value p^r with the anticipated bias b. Nor do they know the true economic value of the share C_0, but they observe the random and unbiased value C_0^M. Before negotiating, they cannot solve (8) to find the equilibrium contract curve.

[15] The first term of (5) is positive. The second one also if we accept that the shareholders' prior forecast p' remains positive after correction. Recall that the derivative of the effort function $e'(.)$ is assumed positive.

[16] We know that: $\frac{\mathrm{d}k*}{\mathrm{d}E*} = -\frac{\mathrm{d}F/\mathrm{d}E^*}{\mathrm{d}F/\mathrm{d}k^*}$ and we note that: $\frac{\mathrm{d}F}{\mathrm{d}E^*} = -(1+k^*).N < 0$.

[17] Proof is available on request contacting the authors.

3.4. The case of information asymmetry for managers

The managers' wealth does not depend on b because they know their real probability of achieving an increase in the economic cash flow. They are nevertheless at a possible noise disadvantage with regard to the stock market price (Bolton et al., 2006). They have direct and internal information allowing them to know the economic cash flow, and from the risk adjusted discount rate r, they have inside information on the real economic value of the share $C_{0,}$. with $\tilde{C}_0^M = C_0 + \tilde{a}$. They know if the firm is over or under-valued on the market. However, their wealth depends on the market value because it is the price they consider to evaluate their capital gains. So, managers (as shareholders) have their wealth exposed to a market valuation risk around the true economic value:

$$\tilde{W}m = \frac{k}{(1+k)}.N.(C_0 + \tilde{a} - E) + p.\frac{k}{(1+k)}.\left(\frac{e(.)}{r}\right) \tag{9}$$

The first derivative versus E is strictly negative. We get the optimum by deriving in relation to k.[18]

$$\frac{\mathrm{d}E\left[U\left(\tilde{W}m\right)\right]}{\mathrm{d}k} = E\left\{U'\left(\tilde{W}m\right).\frac{\mathrm{d}Wm}{\mathrm{d}k}\right\} = \frac{1}{(1+k)^2}.\left\{\begin{array}{l} E[Um'].N.(C_0 - E) + N.E[Um''].\mathrm{cov}(Wm,a) + \\ p.E[Um'].\frac{e(.)}{r} + E[Um'].p.k.(1+k).\frac{e'_k(.)}{r} \end{array}\right\} \tag{10}$$

with $Um = U(Wm)$.

After dividing by $E[U'(Wm)]$ and some manipulation, the derivative of managers' expected wealth has the same sign as:

$$\mathrm{sgn}\frac{\mathrm{d}E\left[U\left(\tilde{W}m\right)\right]}{\mathrm{d}k} = \mathrm{sgn}\left\{N.(C_0 - E) + \frac{E[Um'']}{E[Um']}.\frac{k}{(1+k)}.N^2.\mathrm{var}(a) + p.\frac{e(.)}{r} + p.k.(1+k).\frac{e'_k(.)}{r}\right\} \tag{11}$$

All terms are positive, except the second because of the negative sign of the second derivative Um''. So, a non-trivial optimum k_m^* for the managers is possible.[19] In case of the absence of market noise, i.e. var(a) equal to zero, all the terms of (11) are positive, so $\mathrm{d}E[Um]/\mathrm{d}k > 0$. In this specific situation, we find the obvious result that the optimum situation for managers is the maximum opening of the capital of the firm. In the general case acknowledging for market uncertainty, the optimal managers' situation is given by setting the derivative (11) to zero:

$$Fm = \left[\frac{N^2.k_m^*}{\left(1+k_m^*\right)}.\frac{E[Um'']}{E[Um']}.\mathrm{var}(a) + p.k_m^*.\left(1+k_m^*\right).\frac{e'_k(.)}{r}\right] + N.\left(C_0 - E_m^*\right) + \frac{p.e(.)}{r} = 0 \tag{12}$$

We call Fm the left hand side of (12). Because of the negative value Um'':

$$\frac{\mathrm{d}Fm}{d\,\mathrm{var}(a)} = \frac{E[Um'']}{E[Um']}.\frac{N^2.k_m^*}{\left(1+k_m^*\right)} < 0 \tag{13}$$

We calculate, at the managers' optimum, the derivative between the exercise price and the market noise. It is negative:

$$\mathrm{sgn}\left(\frac{\mathrm{d}E_m^*}{d\,\mathrm{var}(a)}\right) = \mathrm{sgn}\left(-\frac{\mathrm{d}Fm/d\mathrm{var}(a)}{\mathrm{d}Fm/\mathrm{d}E_m^*}\right) = \mathrm{sgn}\left[\frac{N^2.\frac{k_m^*}{(1+k_m^*)}\frac{E(Um'')}{E(Um')}}{N}\right] < 0 \tag{14}$$

[18] Using the formula: $\mathrm{cov}(f(x),y) = E(f'(x)).\mathrm{cov}(x,y)$ (Cf. Losq and Chateau (1982)), we get: $E[U'(\tilde{W}m).\tilde{a}] = E[U''(\tilde{W}a)].\mathrm{cov}(\tilde{W}m,\tilde{a})$.

[19] Insofar as they are risk averse. If $U''=0$, their optimum is clearly the maximum opening of the capital. For its part, the derivative of the expected wealth versus E remains strictly negative.

After simplification, the derivative of Fm with respect to k^* has the sign of:[20]

$$\operatorname{sgn}\frac{\mathrm{d}Fm}{\mathrm{d}k_m^*} = \operatorname{sgn}\left[N^2.\frac{E[Um'']}{E[Um']}.\mathrm{var}(a) + f'.\left(\frac{X_0 + p.e(.)}{r} - N.E\right).\frac{p}{r}.\left(\frac{1}{1+k_m^*}\right)^2\right] \tag{15}$$

The equilibrium relationship between E and k for the managers has the same sign as $\mathrm{d}F_m/\mathrm{d}k_m$. From Eq. (15), we see that $\mathrm{d}k_m^*/\mathrm{d}E_m^*$ has an undefined sign; its first term is negative and the second is positive. Consequently, the managers possibly face two different economic logics to design a contract: either a positive trade-off expressing an efficient effort function f' or a possible entrenchment with a transfer of value from the shareholders to the managers (see Fig. 1). In the case of a trade-off, managers know that their effort function is profitable for them and the firm. There is less of a need to ask for a dilutive transfer of value through a discounted exercise price in the contract setting. They may even be willing to accept out-of-the money stock options as far as they are confident with the perspective of creating extra value, in exchange for a higher stake of capital. In the second case, inefficiently stimulated managers with poor possibilities of creation of extra cash-flow will be diluted when awarding a fraction k of capital through stock options. They know it and ask for a larger discount in the exercise price E to compensate the dilution. Identifying the context is of the utmost importance for shareholders. This justifies a negotiation process between the two parties.

We saw (looking at Eq. (14)) that the curve of the optimal contracts for managers in the two dimensions plan (E, k) has a sign which depends on the magnitude of var(a). The existence of market uncertainty (var(a)) combined with risk aversion (negative second derivative of $Um(.)$), will lower the equilibrium level for managers. It moderates the incentive effect of opening the equity capital to managers. The higher the volatility in the market noise, the higher the capital opening should be (for a given exercise price), to stimulate the managers appropriately. Ceteris paribus, a strong volatility in the market increases the size of the stock option grant. For a low volatility of the market price (or a low risk aversion), the contract equilibrium curve for managers remains an increasing function of k (through the positive last term in relation (15)).

Risk-averse managers are not encouraged by an unlimited opening of the capital of the firm (cf. Lambert et al., 1991). The optimal equilibrium level is an inverse function of var(a). A market noise leads to the fear of an over-evaluation of the actual value of the stock. We may imagine that, for a given value of E and a high value of var(a), k_m^* becomes lower than k_s^*. So, the managers do not want to have “too much” ownership of the firm. They implicitly ask for a discount. Moreover, for a given value of E, there is no reason why k_m^* from relation (7) and k_s^* from (12) should be the same.

4. The setting of an optimal contract

4.1. The design of a stock option plan and the negotiation process

From the previous results, we can draw some conclusions on the way a trade-off may develop. The existence of a process of negotiation between shareholders and managers should be underlined because the former need information

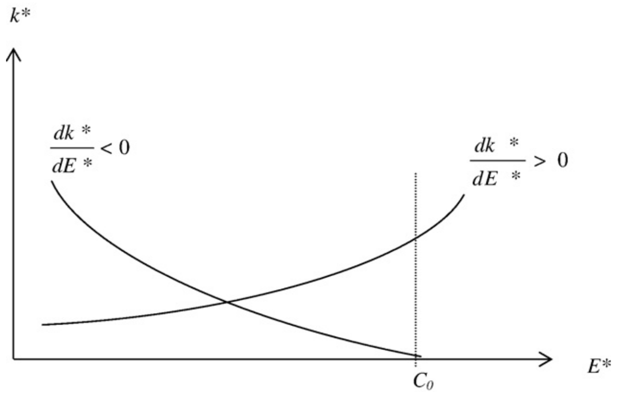

Fig. 1. Relationships between k^* and E^*.

[20] Proof is available on request.

on the sign of the relationship between k_m^* and E_m^* from the managers' point of view and on the location of their optimal contract curve. Both parties know the existence of a positive effort function. They have to fix the parameters of the contract, but they have partial information regarding the shape and the calculation of the function itself. It should be recalled that the gain of cash flow depends on the managers' utility function. Shareholders have little information about this. So, even if the function of cash flow gains is identified precisely, the exact knowledge of the derivative of the effort function f' is asymmetrical. Shareholders do not know if the effort function is fairly or poorly "productive", i.e. if f' is high or low. Moreover, shareholders do not know the real value p here because they only have an estimate of the distribution of information bias b. A negotiation process will induce the delivery of a piece of private information and can lead to seeing in which logic managers stand "vis-à-vis" the shareholders. The latter know that the final percentage of issued capital and the exercise price setting is their legal responsibility. They can arbitrarily set values for E and k, and force the managers to accept a solution which is not located on their own equilibrium relationship between E_m^* and k_m^*. It will lead to a sub-optimal situation, even if, in absolute terms, both parties increase their wealth. A process of negotiation needs to develop because, in the case of deviation versus the optimum incentive equilibrium, managers will have an interest in signaling their loss of opportunity to shareholders. The setting of an optimal contract entails an exchange where, explicitly or implicitly, managers are delivering information. Because they are (hypothetically) rational, the counter propositions they issue should be located on their (unique) equilibrium contract curve (see Eq. (12)).

We have to analyze the iterative process of negotiation between the two parties in order to define the terms of the optimal incentive contract. The first step is to identify situations of effectively incentive or non-incentive stock option plans. At that level, shareholders do not know the sign of the slope of the managers' optimal contract curve (12). At the beginning of the process, the shareholders will offer one set of two values (E_s^0, k_s^0) the optimality of which they do not know. The managers are asked to reply by offering two pairs of values $(E_{m,1}, k_{m,1})$ and $(E_{m,2}, k_{m,2})$. The shareholders look at the relationship $\Delta k/\Delta E$ in the managers' response. The sign will tell whether they are in a trade-off equilibrium context that leads to a positive relationship between E^* and k^* (see Fig. 2-a). Conversely, if the set of the managers' replies are such that $k_{m,1}>k_{m,2}$ and $E_{m,1}<E_{m,2}$, we find ourselves in the opposite scenario where the dominant logic is dilution of their wealth and entrenchment of managers. Stimulation using stock options is then largely ineffective, and it is necessary to give managers both a large share of the capital and a strong discount (Fig. 2-b).

The success, or not, of a bargaining process leading to equilibrium depends on the information on the sign of the relationship. If dk_m^*/dE_m^* is positive, it will stimulate shareholders to trade-off between capital share opening and discount in the subscription price, which is in line with their own rationale. A second step in the negotiation process may then develop (see below). In the opposite situation of a negative relationship between the percentage of awarded capital and the subscription price, the negotiation, from the shareholders' point of view will not converge on an equilibrium agreement (see Fig. 2-b). Following down the managers' optimal contract curve, shareholders can find contracts with higher exercise price and lower fraction of awarded capital. Step by step, it leads to a situation where no stock option plan is issued because managers are considered as potential diverters and have no access to the capital. If the negotiation

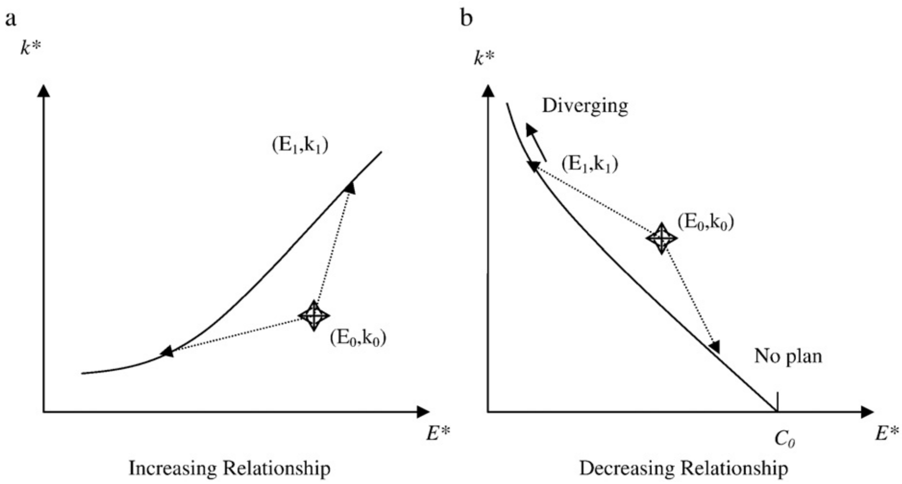

Fig. 2. Separating process of negotiation.

process moves the other way up, the process diverges because, step by step, the equilibrium relationship leads to the maximum percentage of issued capital. It will drive away the shareholders and allow managers to buy the firm with an almost zero exercise price. Their attitude is thus revealed and the process of negotiation will not succeed. So, in a situation where $\mathrm{d}k^*/\mathrm{d}E^*$ is negative, the negotiation will theoretically not result in an agreement on a stock option plan.

It follows that only optimal contracts negotiated within conditions of a sound trade-off between a larger discount in price or a larger share of the capital will appear.[21] The existence of a process of negotiation should eliminate the “inefficient” stock option plans, i.e. those based on entrenchment, opportunism of managers and/or diversion linked to a transfer of wealth from diluted shareholders. Theoretically, it ensures that only stock option plans based on a trade-off that eliminates fear of opportunism will emerge.

4.2. Condition of a unique equilibrium

The optimum conditions (7) and (12) to be jointly satisfied will lead to different equilibrium values k_s* and k_m*. We might doubt the existence of a unique incentive scheme for shareholders and managers. This would disregard the fact that a stock option plan is characterized by a double set of values k and E. Two parameters exist to stimulate optimally the managers and to optimize the wealth of both parties. The two optimum conditions that have to be satisfied define a system of two equations with two unknown values k* and E*, assuming other variables are given. The system of two relationships (16a) and (16b) will lead to a joint equilibrium, both groups are aware that the effort of the managers a priori depends on an optimal percentage of capital issued through stock options.

$$\left\{N\left(C_0 - E^*\right) + p^r\left(\frac{e(.)}{r} - \left(1+k^*\right).\frac{e_k'(.)}{r}\right) - b.\left(\frac{e(.)}{r} - \left(1+k^*\right).\frac{e_k'(.)}{r}\right)\right\} = 0 \tag{16a}$$

$$\left[\frac{N^2.k}{(1+k)}\cdot\frac{E[Um'']}{E[Um']}.\mathrm{var}(a) + p.k^*.\left(1+k^*\right).\frac{e_k'(.)}{r}\right] + N.\left(C_0 - E^*\right) + \frac{p.e(.)}{r} = 0 \tag{16b}$$

A second step occurs in the negotiation process because the joint negotiation system depends on the two variables var(a) and $p'=p^r-b$. Previously we saw, at the managers' optimal equilibrium, that the relationship between the exercise price and the stock market volatility is negative (Eq. (14)). The managers are inclined to deliver fair information on the cash flow and the real value of the firm. This attitude allows them to improve their optimal level of wealth when negotiating the stock option plan by informing the shareholders. Managers will avoid the risk of being granted stock options when stocks are relatively overvalued. By lowering the market noise as perceived by shareholders, they can face a less risky option plan and they agree to pay a higher exercise price. The slope of the equilibrium between E and k for managers changes with var(a). From (15), we get:

$$\frac{\mathrm{d}k_m^*/\mathrm{d}E_m^*}{d\,\mathrm{var}(a)} = \frac{\mathrm{d}Fm/\mathrm{d}k_m^*}{d\,\mathrm{var}(a)} = N^2.\frac{E[Um'']}{E[Um']} < 0 \tag{17}$$

The slope reverses with increasing var(a). A strong market noise can make the optimal curve negatively sloped, resulting in a non-convergence of the negotiation process (see above). Lowering var(a) makes the slope positive and steep, i.e. offers a better trade-off when managers negotiate with the shareholders. If managers accept a small increase in exercise price ΔE, they will obtain a higher percentage of equity capital Δk with a lower value of var(a) than with a higher value (see Fig. 3). This is an incentive to (partially) deliver information lowering var(a) and move the equilibrium in favor of their interest.

The slope of the equilibrium curve for shareholders depends on (p^r-b). But when p^r moves, the correction term b will move symmetrically in the other direction, so the slope will not change.

$$\frac{\mathrm{d}k_s^*/\mathrm{d}E_s^*}{\mathrm{d}(p^r-b)} = \frac{\mathrm{d}Fs/\mathrm{d}k_s^*}{\mathrm{d}(p^r-b)} = -(1+k)\frac{1}{r}\frac{\mathrm{d}e_k'(.)}{\mathrm{d}k} > 0 \tag{18}$$

[21] Canil and Rosser (2007) found that moneyness seems positively although not significantly related with the relative size of a stock option plan in a sample of Australian firms.

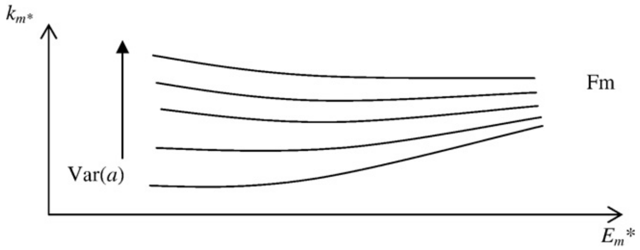

Fig. 3. Influence of market noise on the managers equilibrium relationships.

For a supposedly positive value of $\mathrm{d}F_m/\mathrm{d}k_m^*$, the locus of optimal contracts for managers is an increasing curve in the two dimensions plan, E and k. If we consider the points characterizing the optimal contracts for shareholders, we also obtain an increasing curve, but of different slope. The two curves cross each other at a single point defining the optimal contract for both shareholders and managers under conditions of uncertainty and market noise (see Fig. 4-a). This optimal incentive contract is unique because of the monotony of the curves for a given set of parameters. If the market noise disappears, the problem becomes simpler because the managers are not pushed to optimize in the same way. If var*(a)* is null, the constraint (16b) falls because the derivative is always positive. An infinite number of optimal contracts exists characterized by a trade-off between the discounted exercise price and the percentage of issued capital given by the equilibrium relationship of shareholders (16a) (see Fig. 4-b). Even in that eventuality, managers can influence the setting of the contract through the information delivered on the probability of success, p^r and b. A noise in the price of the stock in the market makes things more complicated for managers, but will lead to the existence of an optimal equilibrium for both parties, thus justifying the hypothesis (1).

The second step in negotiations develops from the initial available information and beliefs. We start with given public information and a reported biased probability p^r issued by managers, which leads to the joint contract terms A in Fig. 5. For the managers, improvement of the expected utility is obtained by moving to the contract equilibrium curve $Fm(\mathrm{var}(a)=0)$ after disclosure of the true economic stock price to the market. The shareholders will receive better information on the probability of success causing their curve to go down and decreasing their expected value $Fs(p')$ from the first reported value $Fs(p^r)$. In fact, the information delivered by the managers after an initial trial p^r should converge on a zero bias for shareholders, i.e. toward their forecasted probability p'. The path of contract terms linked to the delivery of information is presented in Fig. 5. Optimally, it should lead to the contract corresponding to O in Fig. 5, i.e. a point where the two parties share the same information on the probability p with the delivery of private information $\mathrm{var}(a)=0$. If p' is above p, it means that the shareholders are still more optimistic than the managers. The latter will continue to deliver them information on p which is trustworthy for shareholders who can only consider the possibility of positive bias. If p' is lower than the true value p, the managers will inform the shareholders that they are too pessimistic and that the true value is higher. Unfortunately, the shareholders can view this information as an exaggeration bias although it is true and can penalize the managers by more supervision or doubt. The shareholders will stay on their prior equilibrium locus $Fs(p')$. The path of contract terms will depart from the optimal curve AO at the intermediary point B and lead to the setting of contract C. The managers standing on the curve $Fm(0)$ are at their

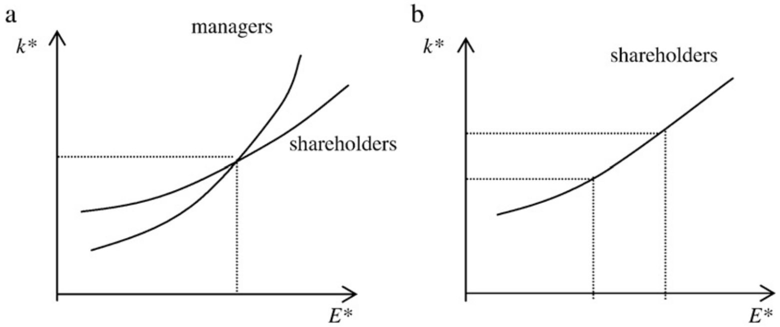

Fig. 4. a Single equilibrium contract. b Multiple optimal contracts.

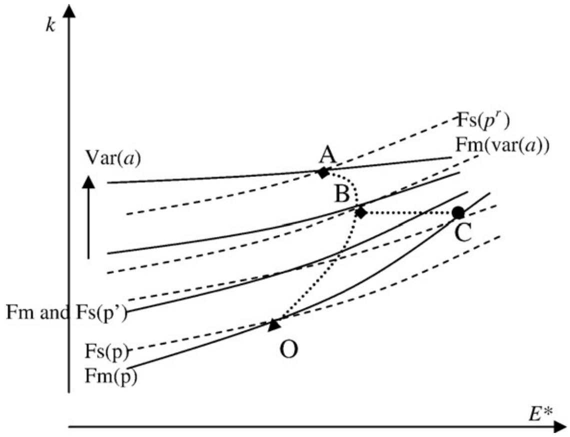

Fig. 5. Second step in the negotiation process (plain line: shareholders equilibrium terms, dashed lines: managers, A: joint contract with information p^r and var(a), B: joint contract with a lower var(a), O: optimal joint contract with an information based on the true probability p, C: improved information set based on p' corrected probability for shareholders and the true probability for managers).

optimum. That situation creates value from the shareholders to the managers through the setting of a "good-for-them" contract. The joint equilibrium is then sub-optimal in the sense that shareholders do not use all the existing information on the probability of success but only a part of it. The process leads to a balanced and partial disclosure of private information with managers disclosing the real economic value of the firm and being constrained to give private information moderately biased and conformed to the prior forecast of shareholders. If p' is above p, the process can stop because that sub-optimal situation is favorable to managers. Shareholders will not be at the ultimate optimal situation *Fs(p)* based on the true value of p. They bear a risk of issuing stock options based on wrong prior ex ante forecasts of success. However, at the portfolio level, these sub-optimization errors will cancel each other because they are specific risks ensuing from independent negotiation process.

As the previous step improves information and optimality of the contract terms through a negotiation process, it only brings a partial disclosure and does not converge in any case on the joint optimal contract. A final step may develop. It will consist in a mechanism pushing managers to disclose the estimates of the true probability of a successful stock option plan and leading shareholders to revise their prior assessment. The difficulty is there to separate that information from the unilateral optimistic reporting. A third step in the process could consist in asking the managers two boundary values around the true probability of success they do know precisely. These values are $p_{\min}$ and $p_{\max}$. Whether the prior p' is outside or inside that range does not matter. The shareholders can use the mean of these two values to set up their equilibrium curve (*p-mean* in Fig. 6) and propose a contract. The equilibrium levels in term of expected wealth are superior from the curve $Fs(p_{\max})$, followed by $Fs(p_{\text{mean}})$, and by $Fs(p_{\min})$. The distance between the three indifference curves *Fs* is approximately the same.[22] The shareholders will play with the managers' risk aversion. For two given exercise prices E_L and E_H, the shareholders will propose four contracts corresponding to the indifference curves calculated from $p_{\min}$ and $p_{\max}$. These contracts are C_{Lmin}, C_{Lmax}, C_{Hmin} and C_{Hmax}. Each one is proposed to the managers. If they are all individually accepted (or rejected), that means that the contract curve of managers (dashed line in Fig. 6) is below (or above) the four points. We modify the limits E_L and E_H until one at least is rejected (C_{Lmin} or C_{Hmin}). If none is rejected that means that the value $p_{\min}$ is overvalued. Having identified one rejected contract, we define a box where the optimal joint contract stands. To be more precise, we set a triangle with 3 points including the rejected contract, for instance C_{Lmin}, C_{Hmin} and C_{Hmax} (see Fig. 6). The managers are then asked to choose between two combinations. Combination A is made with 50% C_{Hmin} (which is the one rejected) and 50% C_{Lmin}. Combination B is 50% of the rejected one and 50% of either $C_{\max}$ or $C_{\min}$ with the same exercise price as the one rejected, here a mix of C_{Hmin} and C_{Hmax}. It corresponds to point B on the $Fs(p_{\text{mean}})$ curve. The risk aversion of the managers will lead them to select the combination with the higher expected utility contract. If combination A is accepted, it means that the managers' contract curve cuts $Fs(p_{\min})$ for exercise price above $(E_L+E_H)/2$. If combination B is accepted, it means that

[22] The derivative of *Fs* with regard to (p^r-b) is $\frac{\mathrm{d}Fs}{\mathrm{d}(p^r-b)} = \left(\frac{e(.)}{r} - (1+k).\frac{e'_k(.)}{r}\right) < 0$. It depends on k, therefore the indifference curves are symmetrical around $Fs(p_{\text{mean}})$ but not strictly parallel.

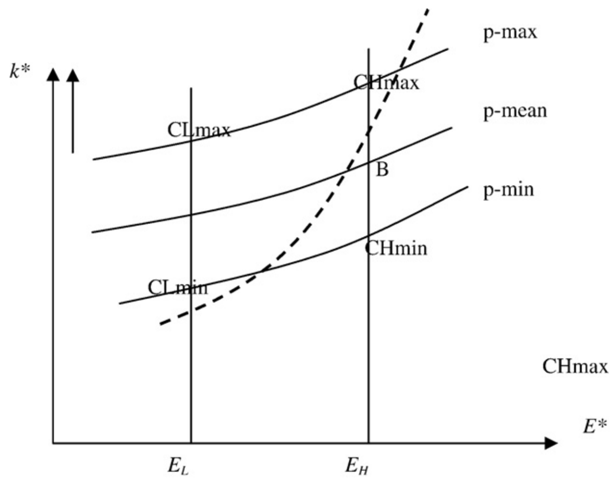

Fig. 6. Third step in the negotiation process (plain line: shareholders' equilibrium contract curves for different values of p probability of success, dashed line: managers' contract curve).

for E_L, the managers' curve is below p_{mean} and that the true value of p is between p_{mean} and p_{min}. Looking at Fig. 6, for E_H, the managers will refuse combination B which is below their contract curve. So shareholders can propose a contract C which is a mix of C_{Hmax} and the contract set using p_{mean}. The process can continue with three or four new points defining a new area. The incentive for the managers is to set a p_{min} probability below the true one otherwise they will be penalized: for instance the negotiation stops and no stock options are awarded or some monitoring tools are enforced to control managers.

The optimal equilibrium for managers depends on the information they issue to the shareholders, but they are not sure that the final contract lies on their optimal curve. Shareholders also are only speculating on the true probability of success. At the end of the process the convergence stops when the difference between expected utility of risk-averse managers and expected wealth of risk-neutral shareholders decreases. Managers, through the p_{max} and p_{min} values, have the opportunity to influence the process of negotiation and participate in setting the conditions, even if the final choice of the percentage of issued capital k and the exercise price E is made by shareholders. The signaling from the managers is very important because it modifies the calculation of the optimal value of the shareholders' wealth. The shareholders are then stimulated by the acquisition of extra-information and enter in an iterative negotiation process. Ultimately, if the perceived information is still excessive or untrustworthy, the shareholders will not grant a stock option plan. Managers are encouraged to give fair information on the real chances of getting additional cash flow. The process of negotiation in itself allows the delivery of information and helps to converge on a joint equilibrium economic contract.[23]

4.3. The design of stock option plans

A first question is raised to argue why managers will not favor direct purchase of undervalued stocks in the market instead of developing a bargaining procees to design stock option contracts. In fact, both can be used complementarily. Using direct stock purchase will not have a negative influence on the use of stock options and will lead to an expected profit equal to the market stock undervaluation. It will not preclude entrenched manager to negotiate stock options and cash-in the discount. They can expect a greater profit even if they are not productively stimulated. If a (inefficient) stock option plan is agreed, they will gain the discount premium and the undervaluation noise for each stock, without making any additional effort. There is another reason for the managers to prefer the stock option grant method. If they purchase stocks, they will increase their over-investment of financial and human capital in the firm. So they will suffer an

[23] The convergence between agents to agree on a joint equilibrium contract is a process where agents are making "subjectivist" choices based on their forecasted utility, risk aversion and opportunity costs. The process focuses on behavior and choices, not on an objective equilibrium variable such as prices in a market. Convergence is the road to common subjective choices made in a market framework or in a pure contractual framework without market (see Buchanan, 1969). "The equilibrium in the 'subjectivist economics' espoused by Hayek is described behaviorally. It is attained when the plans of participants in the economic interaction process are mutually satisfied. Although prices continue in this equilibrium to bear some relationship to costs, such costs carry no objective meaning" (p50).

additional cost of under-diversification. This is consistent with the manager's portfolio adjustment highlighting a decreasing stock ownership when they are awarded new stock options (Ofek and Yermack, 2000).[24]

A screening process separates efficient and non-efficient stock option plans, i.e. managers with productive effort function and those with poorly productive effort function. If the bargaining process is implicit and mute, the market will only see the ex post agreement of efficient stock option plans. It will be positive news and the market will react positively. This may explain the greater occurrence of empirical test concluding to positive abnormal returns. If the negotiation process is explicit, the market will know that a bargain is developing. It should also be ex ante good news since either it fails and nothing happens, or it succeeds and it will signal a productive stock option plan. Market reaction can also be negative when, informed of the existence of a bargaining process, it fails. It will signal the existence of managers with poor efficient effort function and the absence of incentive opportunity.

In the case of a sufficient additional cash flow due to a productive effort from managers (high f', so $\mathrm{d}k^*/\mathrm{d}E^* > 0$), a fair incentive contract can be set on the basis of a trade-off between the percentage of capital awarded and the discount. If, for any reason, a null discount becomes mandatory, the optimal rate k^* will then be unique. The shareholders will then have no opportunity to choose, nor will they have any opportunity to build a stock options policy based on a trade-off between k^* and E^*. The absence of discount possibilities will limit the choices and dramatically increase the eventuality of poor management incentive policy. In most cases these plans will be sub-optimal and open the way to strategic behaviors. Any legal or contractual restriction limiting or prohibiting a discount (or a premium) in the subscription price is harmful and can entail a social cost.

We can imagine situations where a fair contract can be set on a premium in the subscription price. This means that managers accept to pay when exercising a price which is above the current stock price. In fact, they are willing to pay a future premium to become shareholders and to get a higher opening of the capital. This acceptance clearly reveals publicly a situation of "productive" effort, i.e. $\mathrm{d}k^*/\mathrm{d}E^* > 0$ which result in a future expected value of the stock C_1 high enough to satisfy the managers' participation constraint $C_1 > E$ with $E > C_0$ (for instance, Desbrières, 1997).

The previous remarks should be placed in a wider perspective if we take into account the tax aspects. We can imagine, if we were in a system of zero or limited taxation on capital gains resulting from the exercise of stock options, that the tax advantage (due to better treatment) could compensate the impossibility of a discount. Let us consider an advantage due to a lower rate of taxation $\Delta T = T_1 - T_2$ with $T_2 < T_1$. The exercise price of the stock options is set at C_0 for exogenous regulation reasons. At maturity when exercising, the stock price is C_1, the tax advantage is $\Delta T.[C_1 - C_0]$. If we compare this with the initial situation where the tax rate was T_1, the profit due to exercising the option is $(1 + \Delta T)(C_1 - C_0)$. Therefore, the tax aspect appears as a multiplicative factor. It underlines the fact that a tax incentive for managers only exists when an exercise profit exists ($C_1 > C_0$). This subscription profit appears only if managers are efficiently stimulated to manage the firm in order to increase its value. When analyzing stock options, the tax hypothesis should be placed after the stimulation hypothesis, although we acknowledge that some empirical studies do conclude on the preeminence of the tax motivation (Long, 1992). However, a discount in the exercise price cannot be seen as similar to a tax saving for two reasons. The first is that a tax system continually changes, which makes this tax advantage random. The second reason is that the tax gain is a proportion of the capital gain, and depends on the tax situation of the involved person. For instance, in some countries, personal tax rates are not fixed, but vary according to the global income of the manager. The discount, in comparison, is known and is fixed from the beginning. Introducing the tax aspect is complex and leads to an option with exotic features (i.e. stochastic exercise price).

Finally, the trade-off between discount and exercise price can induce a negative effect related to an element which is ignored in the model: a possible loss of control by shareholders. When trading-off, the shareholders may fear diversion and react by offering a very high discount, but if they increase the opening rate, the capital will be diluted and they can lose their control. However, if they focus only on the dilution risk, they may accept a sub-optimal stock option contract which generates a lower increase in cash flow compared to what would have been possible. In such a situation, they "pay" the implicit cost to maintain their control of the firm.

The existence of asymmetry of information highlights the importance of a negotiation process, which has two major consequences: it eliminates non-incentive stock option plans, and it induces the partial delivery of information leading

[24] We thank a referee for pointing out the incentive for managers to enter in a bargaining process instead of direct stock purchase. To imagine a substitution effect between direct purchase and bargaining stock options, we should incorporate a specific cost representing the effort to bargain. We should symmetrically do the same for the shareholders. It will make the model complex. The results will depend on the functional forms of these cost functions.

to the definition of an optimal contract for both parties. We can draw testable hypotheses from the above analysis: (a) Incentive efficient and non-efficient stock option plans are screened in a negotiation process. As a result, stock option plans emerging from a negotiation process should bring an increase in cash flow, are good news and will entail positive stock market reactions. Conversely, failures in the negotiation of stock option plans may explain negative market reactions. (b) At equilibrium, for incentive efficient stock option plans a trade-off appears between the exercise price and the percentage of capital awarded. (c) Delivery of information in the negotiation process will reduce the stock price volatility.(d) In the negotiation process context, for a given exercise price, a high volatility in the stock price should result in a higher percentage of stock options awarded to managers.

5. Conclusion

A stock option plan is a contract whose optimum is quite subtle and does not follow the rationale of mandatory choices imposed by shareholders. Two variables appear to be of prime importance, the percentage of issued capital and the subscription price of new stocks. Granting a stock option plan without questioning the values of these two parameters or considering only one of them will certainly not lead to a situation of an optimal equilibrium. Any contractual agreements or legal rules allowing or introducing restrictions in defining an optimal incentive contract between shareholders and managers will induce a social cost of mis-optimization. Then the conclusions of this research apply regardless of the country and the current legal rules within stock option contracts.

We show that an iterative process of explicit or implicit negotiation brings value to shareholders. The negotiation of stock option plans provides a way to control managers' actions and invites them to disclose information about the possibilities of generating extra cash-flow. The "managerial power" approach appears to be compatible with the standard incentive theory especially since the contract design mechanism is based on negotiation. In such a context, the shareholders may question the willingness of managers to increase the economic cash flows. It is known that a stock option plan can be an opportunity for the managers to "settle down" in the firm and divert a part of the economic value. We show that, where efficiency and additional profit are low due to the managers' actions, the negotiation process will delineate situations where the increase in cash flow is not high enough for the shareholders to avoid dilution. The problem, in a framework of asymmetry of information, is to detect stock option plans that lead to a productive stimulation of managers and creates wealth for both parties. In such a situation, an optimal equilibrium exists characterized by a trade-off between the percentage of capital issued to newcomers and the discount in subscription price. A selection mechanism between "good and efficient" stock option plans for the two parties, on the one hand, and "bad and inefficient" plans, on the other, develops in the negotiation process and, if shareholders and managers are completely rational, will theoretically result in only efficient plans. To ensure that the negotiation process leads to an optimal solution, the choice should not be restricted by either party or by an external regulator. If regulations are implemented, the negotiation process is not unquestionably efficient in delivering to shareholders private information about the real probability of gain of cash flow.

Moreover, the negotiation process is pegged with information policy from the managers to shareholders. In itself, it conveys extra information in case of bias in the economic perspectives or mispricing in the valuation of the stock on the market. Joint negotiation equilibrium will exist in that situation; it is defined by trade-off conditions between the percentage of issued capital and the discounted price. From a legal point of view, however, a stock option plan is the decision of shareholders, the latter are interested in obtaining information they do not have on the true probability of increasing the cash flow of the firm or on the true value of the stock behind the market noise. Because the managers benefit better information, and because that asymmetry is taken into account by shareholders in the form of a risk in information quality, the former are inclined to deliver information in order to improve the optimum level for both parties.

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